Claims

1. A heat exchanger system for cooling a fiber moving continuously through the heat exchanger, comprising:

an outer tube section;

an inner tube section disposed within and separated a selected distance from the outer tube section to form an annular gap therebetween, wherein the inner tube section includes an internal passage configured to receive and cool the fiber as the fiber moves through the heat exchanger; and

a plurality of fins extending transversely from internal peripheral wall portions of the inner tube section toward a central axis of the inner tube section, wherein the fins facilitate heat transfer between a cooling medium flowing through the annular gap and a coolant fluid flowing within the inner tube section during system operation.

2. The system of claim 1, wherein the fins are formed by a spiraling element extending in an axial dimension along an internal periphery of the inner tube section.

3. The system of claim 1, wherein the fins are hollow to permit cooling medium to flow from the annular gap into portions of the fins.

4. The system of claim 1, wherein the internal passage includes a plurality of active zones that direct the coolant fluid toward the fiber to facilitate cooling of the fiber within the active zones and a plurality of passive zones that direct the coolant fluid away from the fiber to facilitate heat transfer between the cooling medium and the coolant fluid in the passive zones.

5. The system of claim 4, wherein the fins are spaced from each other along an axial dimension of the inner tube section and the active and passive zones are at least partially defined along a portion of the fins.

6. The system of claim, wherein the fins are hollow and are configured to permit cooling medium to flow from the annular gap into portions of the fins.

7. The system of claim 5, wherein the passive zones are at least partially defined within spaces formed between adjacent fins.

8. The system of claim 7, further comprising:

a plurality of cooling enclosures, each enclosure being disposed within the space defined between adjacent fins so as to define a sub-chamber between the enclosure and the adjacent fins, wherein the cooling enclosures are hollow and configured to receive a cooling medium to facilitate heat exchange between the coolant fluid and the cooling medium within at least the passive zones.

9. The system of claim 1, further comprising:

a coolant fluid inlet and a coolant fluid outlet in fluid communication with the internal passage and disposed at axially spaced locations along the heat exchanger; and

a recycle line connecting the coolant fluid outlet to the coolant fluid inlet.

10. The system of 9, further comprising:

a mechanical device disposed within the recycle line to establish a pressure differential within the heat exchanger between the coolant fluid inlet and the coolant fluid outlet.

11. The system of claim 10, wherein the mechanical device is at least one of a pump and a fan.

12. The system of claim 9, wherein the coolant fluid inlet is disposed between first and second ends of the heat exchanger, the coolant fluid outlet is disposed proximate the first end of the heat exchanger, and the heat exchanger further comprises a second coolant fluid outlet in fluid communication with the internal passage and disposed proximate the second end of the heat exchanger.

13. A method of cooling a fiber in a heat exchanger system, the system including a heat exchanger with an outer tube section, an inner tube section disposed within and separated a selected distance from the outer tube section to form an annular gap therebetween, and a plurality of fins extending transversely from internal peripheral wall portions of the inner tube section toward a central axis of the inner tube section, the method comprising:

passing a fiber through an internal passage of the inner tube section between the fiber inlet and the fiber outlet;

directing a cooling medium through the annular gap; and

directing a coolant fluid through the internal passage of the inner tube section and around the fins to facilitate heat transfer between the cooling medium and the coolant fluid.

14. The method of claim 13, wherein the fins are formed by a spiraling element extending in an axial dimension along an internal periphery of the inner tube section.

15. The method of claim 13, wherein the fins are hollow to permit cooling medium to flow from the annular gap into portions of the fins.

16. The method of claim 13, wherein the coolant fluid is at least one of helium, neon, argon, krypton, xenon, hydrogen, nitrogen, and carbon dioxide.

17. The method of claim 13, wherein the cooling medium is at least one of water, a cryogenic fluid, a liquid hydrocarbon and a gaseous hydrocarbon.

18. The method of claim 13, wherein the coolant fluid is directed through the internal passage in an undulating manner between active zones and passive zones, the coolant fluid being directed toward the fiber within the active zones to facilitate cooling of the fiber and the coolant fluid being directed away from the fiber in the passive zones to facilitate heat transfer between the cooling medium and the coolant fluid within the passive zones.

19. The method of claim 18, wherein the coolant fluid is forced through the internal passage in the undulating manner between the active zones and the passive zones by a mechanical device.

20. The method of claim 18, wherein the fins are spaced from each other along an axial dimension of the heat exchanger, and the active and passive zones are at least partially defined along a portion of the fins.

21. The method of claim 20, wherein the fins are hollow, and the method further comprises:

flowing the cooling medium into the fins to facilitate heat exchange between the cooling medium and the coolant fluid within at least the passive zones.

22. The method of claim 20, wherein the system further includes a plurality of hollow cooling enclosures, each enclosure being disposed within the space defined between adjacent fins so as to define a sub-chamber between the enclosure and the adjacent fins, wherein the sub-chambers at least partially define the passive zones to direct coolant fluid away from the fiber, and the method further comprises:

flowing the cooling medium into the cooling enclosures.

23. The method of claim 13, further comprising:

recycling the coolant fluid between a coolant fluid inlet and a coolant fluid outlet in fluid communication with the internal passage and disposed at axially spaced locations along the heat exchanger.

24. The method of claim 23, wherein the system further includes a mechanical device disposed within the recycle line, and the coolant fluid is recycled by establishing a pressure differential within the heat exchanger between the coolant fluid inlet and the coolant fluid outlet.

25. The method of claim 24, wherein the mechanical device is at least one of a pump and a fan.

26. The method of claim 23, wherein the coolant fluid inlet is disposed between first and second ends of the heat exchanger, the coolant fluid outlet is disposed proximate the first end of the heat exchanger, the heat exchanger further includes a second coolant fluid outlet in fluid communication with the internal passage and disposed proximate the second end of the heat exchanger, and the coolant fluid is further recycled between the coolant fluid inlet and the second coolant fluid outlet.

27. The method of claim 13, wherein the fiber is an optical fiber.

28. A heat exchanger system for cooling a fiber moving continuously through the heat exchanger, comprising:

an outer tube section;

an inner tube section disposed within and separated a selected distance from the outer tube section to form an annular gap therebetween, wherein the inner tube section includes an internal passage configured to receive and cool the fiber as the fiber moves through the heat exchanger; and

a means for facilitating heat transfer between a cooling medium flowing through the annular gap and a coolant fluid flowing within the inner tube section during system operation, wherein the means for facilitating heat transfer extends transversely from internal peripheral wall portions of the inner tube section toward a central axis of the inner tube section.